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RETENTION VALUE OF FILMED SCIENCE COURSES.

BY- BLACK, WILLIAM A. AND OTHERS
KANSAS STATE COLL. OF PITTSBURG

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THIS INVESTIGATION WAS TO DETERMINE THE EXTENT OF SUBJECT MATTER RETENTION IN FILMED PHYSICS AND CHEMISTRY COURSES AS CONTRASTED WITH SUBJECT MATTER RETENTION IN CHEMISTRY AND PHYSICS CLASSES TAUGHT IN THE CONVENTIONAL MANNER. RESULTS OF THE ANALYSES LEAD TO THE CONCLUSION THAT NO DIFFERENCE EXISTED IN THE AMOUNT OF INFORMATION RETAINED BETWEEN THE FILM-TAUGHT AND CONVENTIONALLY TAUGHT PHYSICS AND CHEMISTRY STUDENTS. ALTHOUGH A RETENTION DIFFERENCE FAVORING THE CONVENTIONALLY TAUGHT CHEMISTRY STUDENTS WAS FOUND 7 MONTHS FOLLOWING COMPLETION OF THE CHEMISTRY COURSE, THE DIFFERENCE WAS NOT SIGNIFICANT AT THE END OF A 12-MONTH POST-LEARNING PERIOD. NO RETENTION DIFFERENCES EXISTED BETWEEN THE TWO PHYSICS GROUPS AT THE END OF EITHER INTERVAL. (LP)

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JOSEPH M. SADNAVITCH

W. JAMES POPHAM

PREPARED UNDER PROVISIONS OF A RESEARCH GRANT
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WILLIAM A. BLACK, PROJECT DIRECTOR
DEPARTMENT OF EDUCATION AND PSYCHOLOGY
KANSAS STATE COLLEGE OF PITTSBURG

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WILLIAM A. BLACK, PROJECT DIRECTOR
Department of Education and Psychology
Kansas State College of Pittsburg

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J. M. S.

W. J. P.

W. A. B.

RETENTION OF SUBJECT MATTER AS A FUNCTION OF FILM SCIENCE COURSES

Introduction*

Two principal instructional outcomes since the very inception of formal education have been acquisition and retention of subject matter knowledge. Although the important retention objective has often not been explicitly asserted, it is usually taken for granted that unless subject matter information acquired in a learning situation is retained, to some extent, then the instructional method was deficient. In fact, to label as effective a method of instruction which did not facilitate retention would indeed be an unusual use of the term.

In recent years the public schools have noted an increased emphasis upon the use of audio-visual techniques for the improvement of instruction. This particular movement is not new, as witnessed by early educational experimentation with the use of motion picture films (Sumstine, 1918; Roulon, 1933) as an instructional procedure. During World War II the movement was enhanced by the development of so-called training films produced by the armed forces. Recently, in the form of year-long filmed secondary school science courses, the motion picture approach has made a new bid for status in the hierarchy of instructional methods.

Many individuals advocating extensive use of the motion picture film in the classroom have made the claim that the chief value of the

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* The research reported herein was supported by a grant from the United States Office of Education, Department of Health, Education and Welfare.

motion picture film is associated with clearer presentation of content so that students better understand and longer remember the materials. To the extent that this assertion is valid, we should expect subject matter acquired by means of motion pictures to be retained longer than that acquired by the traditional learning methods.

Yet, judging from the paucity of retention studies which deal with educational films, one might suppose that the educational researcher had overlooked this important area of study. In reality, this apparent deficiency may be due to the inherent difficulties associated with any investigations of retention (e.g., student attrition, prolonged relationship with participating schools, etc.). Such difficulties are no less present in retention investigations of educational films.

This report describes an experiment in which the extent of subject matter knowledge retained under filmed and conventional modes of instruction was contrasted. The filmed method of instruction involved the use of the completely filmed courses in secondary school science produced by Encyclopaedia Britannica Films, Inc.

The retention phase of the research is actually an extension of an earlier project conducted during the 1959-60 school year by Kansas State College of Pittsburg under a grant from the United States Office of Education. In order to properly interpret the present retention study, a knowledge of the 1959-60 Science Films Research Project is important. A summary of that phase of the research is supplied in the following paragraphs.[1]

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[1] For the monograph describing the 1959-60 study see: Popham, W. J. and Sadnavitch, J. M., The Effectiveness of Filmed Science Courses in Public Secondary Schools. Kansas State College of Pittsburg, August, 1960, 66 pp.

Summary of 1959-60 Study

The purpose of the study was to evaluate the Encyclopaedia Britannica Films, Inc. filmed physics and chemistry courses in terms of their influence on end-of-course student achievement, interest, and attitudes. Year-long courses in high school physics and chemistry were taught by two methods: (1) using filmed lessons, in which students viewed approximately one 30-minute lecture-demonstration film per day supplemented by class discussion, and (2) using a conventional non-film classroom teaching approach. A total of 149 physics and 132 chemistry films were viewed during the academic year. Student subject matter achievement, interest in physical science, and attitude toward the subject matter were measured at the beginning and end of the academic year. Standardized tests as well as instruments specially designed for the project were employed in the research.

Analysis of covariance was used to test differences between film and non-film groups with respect to subject matter achievement. Non-parametric techniques were used to analyze attitude and interest data.

The research sample was drawn from students enrolled in 12 southeast Kansas secondary schools, six schools serving for the filmed physics and non-film chemistry instruction and six schools for the non-film physics and filmed chemistry instruction. Schools in the two groups were matched according to several school characteristic factors. Of the 247 physics students, 135 were taught by film and 112 in the conventional manner; of the 446 chemistry students, 235 were taught by film and 211 conventionally.

Results of the study indicated that the achievement performance of the non-film group in physics was significantly superior to the film group. There were no significant achievement differences between the two chemistry groups. There were no significant differences between the two physics groups in their interest in physical science. The lower ability chemistry film-taught students showed significantly less interest in physical science than the comparable non-film group. Although both groups (experimental and control) in physics and chemistry evidenced a more unfavorable attitude toward physics and chemistry as school subjects at the conclusion of the study than they did at the beginning, the film groups' attitudes were significantly more unfavorable than those of the non-film groups.

Purpose of the Present Study

The purpose of this investigation was to determine the extent of subject matter retention promoted by filmed physics and chemistry courses as contrasted with subject matter retention yielded by chemistry and physics classes taught in the conventional manner. The recall method of retention assessment was employed. Two specific post-learning retention intervals were designated, i.e., seven months and 12 months. Specifically, the study was designed to test the following hypotheses:

1. Students enrolled in film-taught chemistry and physics classes do not differ significantly from students enrolled in conventionally taught chemistry and physics classes with respect to retention of subject matter after a seven month post-learning interval.

2. Students enrolled in film-taught chemistry and physics classes do not differ significantly from students enrolled in conventionally taught chemistry and physics classes with respect to retention of subject matter after a 12 month post-learning interval.

Relevant Research

At least two general types of research results must be considered relevant to the present study--those studies which deal with the educational utilization of the Encyclopaedia Britannica Films, Inc. filmed chemistry and physics courses, and the research which centers upon retention of subject matter where filmed media is used for instruction. A number of the science studies were reviewed in the research report of the initial phase of this project[2] and will not be treated again here.[3] Since the retention type was not reviewed in the earlier report, an examination of the literature on this topic will be presented below.

Roulon (1933) cited 32 experimental film comparisons which appeared in the early literature regarding the use of film. In 13 of the comparisons where the retention factor was considered, the film techniques proved superior. In no case did the non-film technique yield superior results. In one of the experiments cited (Knowlton and Tilton), pupils were tested three months after the

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[2] Ibid., pp. 1-6.

[3] A more recent review of such projects will be found in the Handbook of Research on Teaching chapter prepared by Dr. Fletcher G. Watson on the Teaching of Physical and Biological Science, American Educational Research Association (in press).

experimental instruction period was over to obtain a measure of retention. The results indicated that the film group excelled the non-film group by approximately 12 per cent on a retention test. Roulon also experimented with films versus standard teaching methods in the area of general science and reported retention superiority for the film-taught students.

Earlier, a study (Sumstine, 1918) designed to investigate the efficiency with which themes could be written after receiving instruction via the motion picture as contrasted with a lecture and a combination of film plus lecture revealed that the film-taught group retained more after periods of 24 hours, ten days, and three months.

Hansen (1933) attempted to determine the contribution of educational motion pictures to the retention of informational learning. This experiment was designed so that an experimental group used films in addition to class discussions while the control group read and discussed class materials. He reported that the knowledge gained through the means of pictorial presentation is fully as permanent as that gained through reading and oral presentation. His conclusions were based on tests of achievement administered ten days prior to the beginning of the unit, immediately after the unit, and three to four weeks after the unit.

Goodman (1943) used sound motion pictures, silent motion pictures, silent film slides and sound film slides in teaching certain topics in safety education to elementary students. The results indicated that all four media were effective devices. The silent motion

picture approach, however, produced the most retention gains as measured by the delayed recall technique. The sound motion picture was reported to have produced the least gain.

Jayne (1944) investigated the informational gains made by pupils listening to the lecture as compared with pupils who viewed a silent motion picture where the materials were similar. He reported that the retention of lecture material revealed the greatest loss during the first three weeks after acquisition, then leveled off to a uniform rate of loss up to 12 weeks. At the end of three weeks, the film group retained 85 per cent of the material and the non-film group 76 per cent. By the 15th week both groups retained 59 per cent of the material.

In another study (Johnson, 1950), the relative effectiveness of films and film strips in teaching geometry was investigated. Retention measures were administered two months after the completion of the prescribed unit. The results indicated that retention was improved by the use of films and film strips. Johnson concluded that the greatest contribution of the films and film strips then available for geometry classes seems to be in the area of applicational learning and retention.

In an investigation by Nelson (1952), an attempt was made to determine if the use of sound motion pictures would have a significant effect on the achievement of high school chemistry students. The results of this investigation indicated that films increased the effectiveness of teaching a unit in high school chemistry but no significant differences were revealed when the groups were evaluated in terms of retention.

In a study (Jenson and Romano, 1956) dealing with science vocabulary and films it was reported that science vocabulary gains scored by the film group generally doubled, and that slower pupils revealed vocabulary gains similar to those of the brighter students. With respect to retention, the results indicated that more of the vocabulary acquired by those pupils using films was retained for a longer period of time. Retention testing took place six months after the completion of the unit.

Recently, an attempt (Wisconsin Physics Film Evaluation Project, 1958) to assess retention of subject matter contrasting a full-length filmed physics course with traditional instructional procedures indicated that the control groups (non-film) retained more physics information than the film groups after a retention interval of three months. This measure was obtained after the students had been instructed by film for one semester.

The studies reported herein reveal no consistent pattern with respect to one of the most important outcomes of instruction. It should be noted that the studies reported did not employ similar media and, therefore, differences might be expected on the basis of materials used.

Method

The Variables. The criterion variable employed in the present retention study was knowledge of subject matter, in this instance, knowledge of the general principles and facts of physics and chemistry.

Several variables were employed for control purposes, i.e., to assure comparability of the experimental and control groups involved in the study. The control measures used in this design were students' knowledge of subject matter (physics or chemistry) at the close of the previous academic year, previous overall scholastic performance, and intellectual aptitude.

The Measures. Measures of student achievement in the investigation were obtained through the use of the Cooperative Physics Test,[4] and the Cooperative Chemistry Test.[5] The Cooperative Physics Test is available in two forms, Form Y and Form Z, each consisting of 77 items of the multiple choice type. The test is divided into two parts with 20 minutes allotted for each. This instrument is designed to measure the extent to which students have achieved the major objectives of a high school physics course. The Cooperative Chemistry Test is available in three forms, Form X, Form Y, and Form Z. The 40-minute test, composed of multiple choice items, is divided into two parts with 25 minutes allowed for Part I (52-54 items) and 15 minutes for Part II (27-29 items). The test is designed to assess student attainment of the principle objectives of a high school chemistry course.

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[4] Cooperative Physics Test. Educational Testing Service, Princeton, New Jersey, 1950.

[5] Cooperative Chemistry Test. Educational Testing Service, Princeton, New Jersey, 1950.

Intellectual aptitude was assessed by the Otis Quick-Scoring Mental Ability Test.[6] The Gamma version of this instrument (Form C) was employed in the study. This test consists of 80 items designed to assess intellectual potential.

The index of students' previous overall scholastic performance utilized in the present study was cumulative high school grade point average obtained during the 1959-60 academic year. All grade point averages were converted to a four point system, i.e., "A" equals 4.00, etc.

Research Sample

The research sample for the retention study was drawn from those students who participated in the 1959-60 science films project and who were enrolled in the 12 participating high schools[7] during the 1960-61 school year. In other words, the students participating in this study were those who were in their junior year of secondary school during the previous science films research project and who, during the retention study, were seniors in their respective schools.

While it would be optimally desirable to have included in the retention phase of the research all students (approximately 700) who participated in the 1959-60 study, practical considerations of locating graduated students and arranging for suitable testing situations

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[6] Otis Quick-Scoring Mental Ability Tests, World Book Co., Yonkers-on-Hudson, New York, 1939.

[7] The 12 southeast Kansas Secondary Schools participating in the research are identified in the acknowledgements page of this report.

prevented this procedure. The student sample of approximately 300 yielded by the present method was considered to provide a reasonable degree of representativeness.

During the fall of 1961, administrators from the 12 schools were invited to participate in the retention phase of the investigation in order to supply more complete data regarding the efficacy of the filmed science courses. Administrators from all 12 schools agreed to participate in the investigation and indicated their willingness to cooperate by administering the tests at the appropriate retention intervals.

The sample utilized in this study included 215 chemistry students, 153 of whom were taught via film, and 85 physics students, 63 of whom were taught by film.

Procedure

The procedure employed in the study included the administration of Form X[8] of the physics and chemistry tests at the end of the first semester of 1960-61 academic year (January, 1961) to the students included in the research sample. At the end of the second semester of the 1960-61 academic year (June, 1961) Form Z[9] physics and chemistry achievement tests were administered. The information regarding intelligence, previous scholastic achievement, and performance

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[8] Form X tests were administered during the 1959-60 project in September, 1959.

[9] Form Z tests were administered during the 1959-60 project in June, 1960.

on the end-of-course achievement tests were available from the 1959-60 study.

Arrangements were made by mail with the school principals for the administration of the retention tests. Tests were administered by local school personnel in each of the 12 schools. Since students were not advised of the approaching evaluation in advance of the test period, it was assumed that in most instances they were not aware of the impending testing operation. This was true for both the initial and second retention testing operations. Tests were administered and returned by mail to the research staff who subsequently analyzed the data.

Analysis of the Data

A single classification analysis of covariance procedure was employed to treat the data in the study. Separate covariance analyses were computed for data accumulated from the first and second retention intervals. In each instance, the control variables utilized were: (1) intellectual aptitude (Otis intelligence quotient), (2) previous overall scholastic performance (grade point average), and (3) performance on the achievement tests administered at the close of the 1959-60 academic year. The analysis of covariance technique permitted a statistical equalization of the control and experimental groups with respect to the three control variables by compensating for initial differences between groups. The resulting test of significance was made after adjusting for these differences. Product moment correlation coefficients were computed between the various measures utilized in the research.

Results

Results of data analyses for chemistry and physics will be reported separately. For both chemistry and physics, results of the analysis of group differences after the seven month retention interval will be reported initially, followed by analysis of the twelve month retention interval data. Means and standard deviations for the control measures involved in all analyses are presented in the Appendix (Tables 13-16).

Chemistry--Seven Month Retention Interval

Intercorrelations. As an initial step in the data analysis, intercorrelations for all measures employed in the design were calculated. These coefficients are presented in Table 1. The relationship of the criterion variable (seven month retention test scores) to the three control variables, i.e., end-of-course achievement (r=.72), intelligence (r=.58), and grade point average (r=.41), indicated the appropriateness of utilizing these measures for control purposes.

Table 1

Intercorrelations of measures employed in the initial retention analysis for 215 chemistry students

Variable	2	3	4
1 Seven month retention test	.72	.58	.41
2 End-of-course achievement test		.51	.43
3 Intelligence			.53
4 Grade point average			

Analysis of Covariance Results. Having adjusted for initial differences between the film-taught and conventionally-taught chemistry groups, the analysis of covariance revealed a significant difference in retention between the performance of the two groups seven months after the academic year during which they completed the chemistry course. The difference favored the conventionally-taught group and was significant beyond the .05 level ($F = 6.10$). The analysis of covariance for experimental and control chemistry student performance on the seven month retention test is presented in Table 2.

Table 2

Analysis of covariance for experimental and control chemistry students' performance on the seven month retention test

Source of Variation	Residuals			F
	Degrees of Freedom	Sum of Squares	Mean Square	
Between	1	268.41	268.41	6.10*
Within	210	9,244.97	44.02	
Total	211	9,513.38		

* Significant beyond the .05 level.

The mean performance of the experimental and control students for the seven month retention test favored the control group, 53.93

to 56.40. When these means were adjusted in order to compensate for the differences between the groups with respect to the three control variables, the difference favoring the control group was slightly increased. Unadjusted means, adjusted means, and standard deviations for the chemistry students' performance on the seven month retention test are presented in Table 3.

Table 3

Chemistry students' seven month retention test unadjusted means, adjusted means and standard deviations

Group	N	Unadjusted Mean	S.D.	Adjusted Mean
Experimental	153	53.93	10.11	53.92
Control	62	56.40	10.61	56.41

Chemistry--Twelve Month Retention Interval

Intercorrelations. Since the student sample varied slightly for the two separate retention tests, correlation coefficients between all measures employed in the analysis of chemistry students' twelve month retention test performance were also calculated. As expected, the relationships between the measures were approximately the same as with data involved in the seven month retention analysis. In Table 4 the intercorrelation of measures employed in the second chemistry analysis for 196 students are presented.

Table 4

Intercorrelations for measures employed in the second retention analysis for 196 chemistry students

Variable	2	3	4
1 Twelve month retention test	.76	.43	.35
2 End-of-course achievement test		.50	.40
3 Intelligence			.53
4 Grade point average			

Analysis of Covariance Results. Unlike the results of the seven month retention test scores, the covariance analysis of chemistry students' twelve month retention interval test performance revealed no significant differences between the film-taught and conventionally-taught groups. The F value yielded by the analysis was 1.12 and was not statistically significant. Results of this analysis are presented in Table 5.

Table 5

Analysis of covariance for experimental and control chemistry students' performance on the twelve month retention test

Source of Variation	Residuals			F
	Degrees of Freedom	Sum of Squares	Mean Square	
Between	1	59.79	59.79	1.12
Within	191	10,172.82	53.26	
Total	192	10,232.61		

As would be anticipated from the results of the covariance analysis, relatively little difference between the experimental and control groups' performance existed on the twelve month retention test. Unadjusted means, adjusted means and standard deviations for the twelve month retention test scores of the conventionally-taught and film-taught students are presented in Table 6.

Table 6

Chemistry students' twelve month retention test unadjusted means, adjusted means and standard deviations

Group	N	Unadjusted Mean	S.D.	Adjusted Mean
Experimental	140	58.79	11.40	58.86
Control	56	59.14	10.48	58.97

To briefly summarize the results of the seven and twelve month retention analyses for chemistry, there was a significant difference in retention favoring the control group seven months after the chemistry course had been completed, but this difference disappeared at the end of a twelve month period.

Physics--Seven Month Retention Interval

Intercorrelations. Intercorrelations for measures employed in the analysis of physics students' performance on the seven month retention test were calculated. These coefficients are presented in Table 7. The relationship of the criterion variable to the three control variables, i.e., end-of-course achievement (r = .71), intelligence (r = .47), grade point average (r = .26), indicated the appropriateness of utilizing these measures for control purposes.

Table 7

Intercorrelations for measures employed in the initial retention analysis for 85 physics students

Variable	2	3	4
1 Seven month retention test	.71	.47	.26
2 End-of-course achievement test		.52	.39
3 Intelligence			.46
4 Grade point average			

Analysis of Covariance Results. Having adjusted for initial differences between the film-taught and conventionally-taught physics students, the analysis of covariance results indicated that there was no significant difference in retention at the end of a seven month period. The F value yielded by the analysis was .26. Complete results of the covariance analysis are presented in Table 8.

Table 8

Analysis of covariance for experimental and control physics students' performance on the seven month retention test

Source of Variation	Residuals			F
	Degrees of Freedom	Sum of Squares	Mean Square	
Between	1	9.76	9.76	.26
Within	80	3,034.77	37.94	
Total	81	3,044.53		

Although the difference between the unadjusted retention test means of the experimental group (53.97) and control group (56.73) was fairly large, this disparity was markedly reduced when adjustments were made for initial differences between the groups with respect to the control measures. Unadjusted means, adjusted means, and standard deviations for the two groups on the seven month retention test are presented in Table 9.

Table 9

Physics students' seven month retention test unadjusted means, adjusted means and standard deviations

Group	N	Unadjusted Mean	S.D.	Adjusted Mean
Experimental	63	53.97	8.37	54.93
Control	22	56.73	9.09	53.98

Physics--Twelve Month Retention Interval

Intercorrelations. While 85 students were involved in the analysis of seven month retention test data, only 73 students were available for the twelve month retention test. Hence, intercorrelations for the measures employed in the analysis of twelve month physics retention were also calculated. The similarity of these coefficients presented in Table 10 to those for the data involved in the seven month retention analysis would, of course, be expected.

Table 10

Intercorrelations of measures employed in the second retention analysis for 73 physics students

Variable	2	3	4
1 Twelve month retention test	.68	.41	.33
2 End-of-course achievement test		.56	.45
3 Intelligence			.46
4 Grade point average			

Analysis of Covariance Results. As in the case of the seven month retention test, no significant differences between the performance of the experimental and control physics students on the twelve month retention test were revealed by analysis of covariance. The F value yielded by this analysis was .81. The complete analysis of covariance results are presented in Table 11.

Table 11

Analysis of covariance for experimental and control physics students' performance on the twelve month retention test

Source of Variation	Residuals			F
	Degrees of Freedom	Sum of Squares	Mean Square	
Between	1	54.67	54.67	.81
Within	68	4,566.29	67.15	
Total	69	4,620.96		

After adjustment for initial differences between groups on the control variables, the twelve month retention test means for conventionally-taught and film-taught students were not widely divergent. Unadjusted means, adjusted means, and standard deviations for the twelve month retention test scores are presented in Table 12.

Table 12

Physics students' twelve month retention test unadjusted means, adjusted means, and standard deviations

Group	N	Unadjusted Mean	S.D.	Adjusted Mean
Experimental	56	53.39	10.98	54.89
Control	17	59.94	8.88	56.48

To recapitulate, no statistically significant differences between the retention performances of film-taught and conventionally-taught physics students were observed after intervals of either seven or twelve months.

Discussion

Results of the retention analyses lead to the conclusion that no meaningful difference in the amount of information retained existed between the film-taught and conventionally-taught physics and chemistry students. Although a retention difference favoring the conventionally-taught chemistry students was found seven months following completion of the chemistry course, the difference was not significant at the end of a twelve month post-learning period. No retention differences existed between the two physics groups at the end of either retention interval.

Limitations associated with a single investigation dictate caution in one's interpretation of the foregoing conclusion. It must also be recalled that the student sample involved in the retention analysis was approximately 40 per cent of the sample involved in the earlier comparisons between the filmed and conventional methods.

The conclusion that no meaningful differences in retention were yielded by the filmed course method and the more conventional method of instruction offers no support to those who claim that films will enable students to better understand and longer remember information. On the other hand, results of the retention study may

be contrasted with the 1959-60 science film investigation in which marked post-course achievement differences were found favoring the conventionally-taught physics students.

In the earlier study, group differences favoring conventionally-taught students on attitudinal, interest, and opinion measures dictated some degree of scepticism regarding the value of the filmed science courses. In the current investigation, with only retention of subject matter knowledge as the criterion, one must conclude that the two methods of instruction yielded comparable retention outcomes.

Appendix

Table 13

Chemistry students' control variable means and standard deviations--seven month retention interval

Group	N	End-of-Course Achievement		Intelligence		Grade Point Average	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Experimental	153	61.19	10.79	114.08	10.27	2.97	.06
Control	62	60.34	9.49	115.84	9.95	3.06	.06

Table 14

Chemistry students' control variable means and standard deviations--twelve month retention interval

Group	N	End-of-Course Achievement		Intelligence		Grade Point Average	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Experimental	140	61.56	10.68	114.36	10.30	2.99	.06
Control	56	61.59	8.78	116.54	9.75	3.10	.06

Table 15

Physics students' control variable means and standard deviations--seven month retention interval

Group	N	End-of-Course Achievement		Intelligence		Grade Point Average	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Experimental	63	55.16	7.44	114.29	9.69	2.88	.07
Control	22	60.09	8.96	115.05	10.79	2.97	.07

Table 16

Physics students' control variable means and standard deviations--twelve month retention interval

Group	N	End-of-Course Achievement		Intelligence		Grade Point Average	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Experimental	56	55.11	7.57	113.63	9.81	2.87	.08
Control	17	60.47	8.91	114.35	11.14	3.09	.06

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